Applying Wireless Sensor Network and Image Processing Technology to an Algae Cultivation System

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***Abstract*- This study proposes to apply wireless sensor, image processing technology and solar energy generator to an algae cultivation system. The major structures include solar energy generator, ZigBee wireless sensor network, and algae cultivation equipment. In this system, the photovoltaic panels produce energy and the charge controller is used to manage the energy consumption. In order to monitor the algae cultivation system, a ZigBee wireless sensor network is applied. It will monitor the environment situations of the cultivation system and supply the information of temperature, and illumination via the computer network. In order to enhance the algae growth, a bubble generator is used to support the air or CO_2. According to the experimental result, the system proposed in this paper can enhance the algae growth and save the energy also.**

***Keywords*—wireless sensor, image processing technology, solar energy generator, algae cultivation system**

1. INTRODUCTION

In recent years because human over-exploitation of energy resources, large amounts of CO_2 is produced which will enhance the greenhouse effect. It causes global warming and climate changed. Therefore, the renewable energy is played an important role today. In this paper, a solar power system [1-2] is applied for an algae cultivation system to reduce the CO_2 concentration of atmosphere. The solar cell can convert light energy to electrical energy by photo conductive effect. The solar power transformation is affected by two major factors which are sun radiation and temperature. In general, the transformation efficiency of solar panel is low, so the maximum power point tracking (MPPT) algorithm [3-4] must be applied to enhance the solar energy.

In addition, the biomass is a very important renewable energy. The traditional biodiesel and biomass alcohol is generated by using plants such as coin etc. That will waste the human food and seriously affect food supporting. If biodiesel and biomass alcohol is generated by using algae, then it will not affect food supporting. Therefore, the algae cultivation is paid more attention in recent years. Many companies and researchers have invested in this research area and developed algae cultivation system [7-8]. There are some factors that will affect the growth of algae, which are the water supply, strength of the light, concentration of CO_2, PH value, and temperature. In order to monitor these factors, one wireless monitoring system is adopted in this system. In this research, one algae cultivation combines wireless transmission technology using ZigBee sensor [6] is developed.

ZigBee is a wireless technology, which is used for short distance wireless transmission. ZigBee has its own unique wireless standard, so it can transmit signals between many different sensors and communicate with each other. Because it is short distance signal transmission equipment, if you want to spread far distance, you should use the deliver way to get to the final PC for analysis and access. This study uses ZigBee wireless sensor network to monitor various environment information and to control the algae cultivation situations. ZigBee has the following characteristics which are power saving, high reliability message transmission, and expansion capability. ZigBee can also be made with other existing internet connection, even via the internet to control two ZigBee devices in different places.

Moreover, in order to monitor the growth of algae cultivation, the image processing technology is applied in this study. We use the digital camera to take the original picture of algae cultivation equipment. Then it applies the color space transformation to judge the situation of algae cultivation. Based on this development it can monitor the growth situation in real time.

2. SYSTEM DESIGN

In this study, one algae cultivation system combines wireless transmission technology by using ZigBee sensor is developed. The light source uses LED light and the PH values are controlled also. In order to monitor the algae cultivation system situations, the ZigBee technology is applied to monitor the lightness, temperature, etc. The major parts of this system include solar power system, ZigBee wireless sensor network, and algae cultivation equipment, which are described as follows. In the solar power system which is consisted of an array of solar photovoltaic (PV) panels to collect solar energy, and through a charge controller to control the power management based on sunshine situations. If the current of PV array is under a certain threshold value, the controller switches to discharge mode, then the electric energy will be supplied by the storage battery or grid power system. The output power of a solar energy system is depended on solar irradiation and temperature conditions. In order to obtain the maximum output power, the maximum power point tracking (MPPT) algorithm is adopted in a solar energy system. In this study, an improved method based on Perturbation and Observation method (P&O) [3-4] is developed. The operation of a PV module can be divided into two characteristic areas. Augmenting the PV module voltage increases the power when operating on the left region of the maximum power point (MPP) and decreases the power when on the right of the MPP. The PV module output voltage and current are detected first to calculate its output power, then the given output power is compared with the preceding one. After comparison, the voltage value is checked once again to avoid power loss caused by miss-judgment. Finally, the duty value is shifted to determine the subsequent step of scaling up or down the load.

In order to monitor the situations of algae cultivation system, a ZigBee technology is applied. ZigBee is a wireless sensor to monitor and control the entire system whose architecture is shown as Figure 1. It monitors important environment information such as lightness, temperature, etc. The information is detected by sensors which transmit them to the receiving terminal device through wireless transmission. This information is also can transmit to a computer and present to users. Moreover, it uses the software to access this information and to the control functions of entire system.

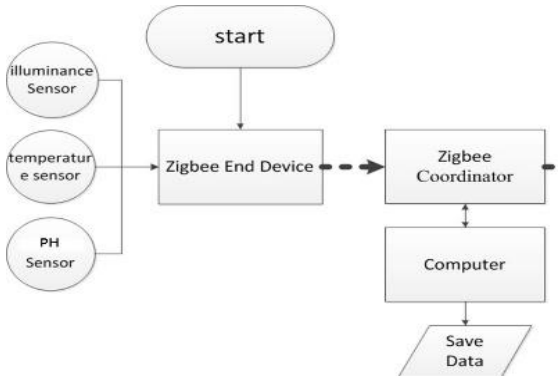

Figure 1 ZigBee wireless sensor architecture

3. IMAGE PROCESSING TECHNOLOGY

This paper proposes an image processing technology to monitor the growth of algae cultivation. It uses the digital camera to take the original picture. In general, all the surveillance system shows the images by using the RGB color space. In order to reduce the computation time, that needs to transfer the RGB color image to grey level image and make the histogram distribution,

This paper does not apply additional noise elimination for simple the processing only using the morphological processing to reduce that. The closing and opening algorithm of morphological processing based on dilation and erosion are useful to fill up the vacancies of segmented foreground objects and to eliminate some noise. These two methods can let the detected objects are more intact to present.

Judgement is based on the histogram analysis to find their proper segmentation threshold values. Pixel distribution state and the cumulative amount of the image project on to the coordinate axis. Based on its distribution histogram, the algorithm identifies a local maximum or minimum of the cumulative pixel position. The algorithm sets the segmentation threshold to achieve the purpose of segmentation. This paper uses the histogram distribution to judge the

growth of algae cultivation. We can set up a database by making more samples. Based on the histogram distribution of grey level for green parts, the system can judge the growth situation of algae.

4. EXPERIMENTAL RESULTS

In order to have better algae cultivation environment, pure water is used. The light source uses LED light and the PH values are controlled also. In the experiment, different situations are considered. One situation just uses the air bubble generator for algae cultivation system. The second situation, the CO_2 is supported to cultivation system 5 minutes per hour. In order to monitor the algae cultivation system situations, the ZigBee wireless network is applied to monitor the lightness, temperature, etc. The algae cultivation system is shown as Figure 2. Based on the experimental result, the second situation has better growth result. It enhances about 20% growth result.

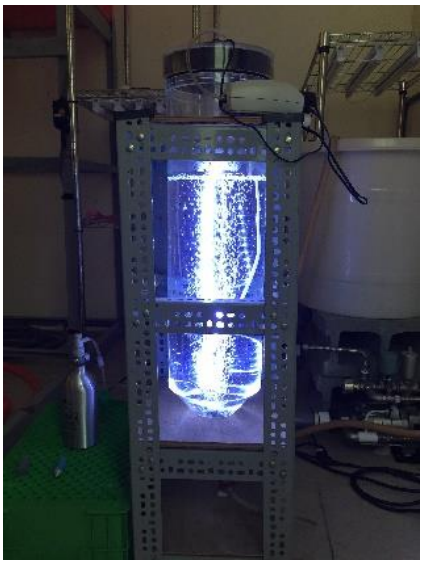

Figure 2 the algae cultivation system

Moreover, this paper uses the histogram distribution of image's green color level to judge the growth of algae cultivation. The experimental result is shown in Figures 3 and 4. The first day image and its histogram distribution are shown in Figure 3. The third day image and its histogram distribution are shown in Figure 4. Based on the histogram distribution, the green color is deeper for Figure 4. Therefore, we know that there are more algae. Based on the database, the system can judge the growth situation of algae.

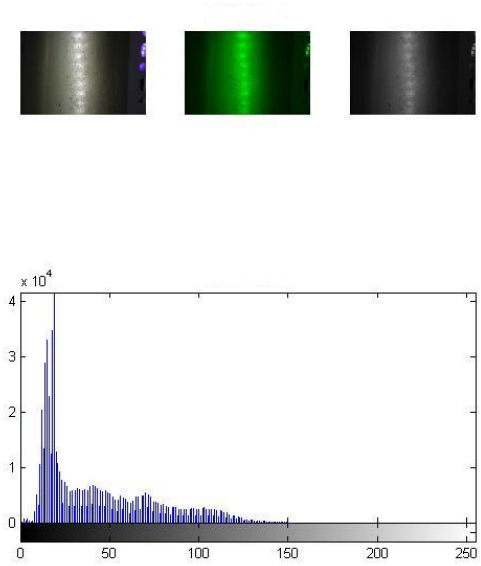

Figure.3 The first day image and its histogram distribution

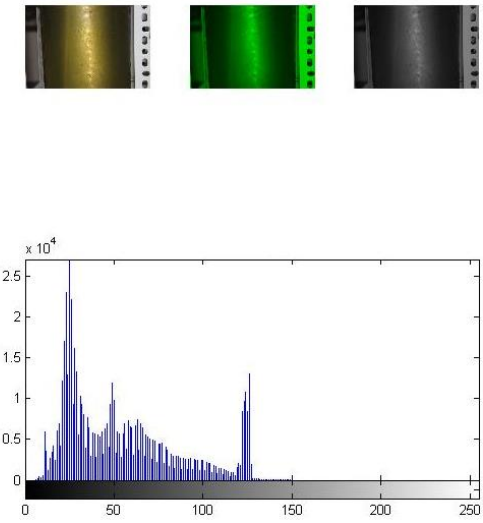

Figure.4 The third day image and its histogram distribution

5. CONCLUSIONS

In this study, one algae cultivation system combines ZigBee wireless network is developed. The LED light source is used and the PH values are under control. In order to monitor the

situations algae cultivation system, a ZigBee wireless sensor network is applied to monitor the lightness, temperature, etc. In order to reduce the amount of CO_2 and greenhouse effect, a solar power generator which is used to support the power of algae cultivation system is applied. Moreover, this paper uses the histogram distribution to judge the growth of algae cultivation. We convince that the system proposed in this paper can enhance the growth of the algae cultivation and reach the goal of saving energy also.

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